U. S. DEPARTMENT OF AGRICULTURE

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THE GREAT BASIN WIREWORM IN THE PACIFIC NORTHWEST

THE GREAT BASIN WIREWORM is costing the farmers of the Pacific Northwest millions of dollars annually in those areas receiving less than 15 inches of precipitation annually. This pest seriously cuts down the stand of both winter and spring grain in the early spring. Damage from this wireworm is especially noticeable in a year with a long cold spring and severe winter injury to the fall-sown grain.

Its long life, together with its ability to withstand drought and starvation, makes this pest hard to control, once it gets a start. The vital time in its life history is during the first summer after hatching from the egg. At this time it must have growing, succulent rootlets of grain or weeds to survive. A brood is being hatched each year. It is therefore essential that clean summer fallowing be practiced conscientiously year after year. A weedy summer fallow for only one season will usually result in damage from wireworms for several years. Clean summer fallow means the killing out of every weed during the whole season.

Absolutely clean summer fallow is the only efficient control for the Great Basin wireworm.

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THE GREAT BASIN WIREWORM[1] IN THE PACIFIC NORTHWEST

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IMPORTANCE AND DISTRIBUTION

THE GREAT BASIN WIREWORM has caused consistent losses to the wheat crop of the Pacific Northwest running into several millions of dollars annually. This wireworm is native to the dry-farming areas of the Columbia and Snake River Basins in Washington, Oregon, and Idaho, where the normal annual rainfall does not exceed 15 inches. (Fig. 1.) Soon after the start of wheat raising in this region some 40 years ago, the Great Basin wireworm changed its feeding, from the bunch grasses on which it originally fed, to include the wheat and other grains.

FIGURE 1.—Distribution of the Great Basin wireworm in the Pacific Northwest. The dots represent specific occurrences. The unshaded portion represents the area with an average of less than 15 inches of precipitation annually

It has increased in abundance under these more favorable food conditions and has readily adapted itself to the system of summer fallowing generally followed in this great dry-farming area.[2]

[1] *Ludius pruininus* Horn, var. *noxius* Hyslop; order Coleoptera, family Elateridae.

[2] For information on the best farm practices adapted to the region under discussion, see the following publications: United States Department of Agriculture Farmers' Bulletin 1545, Dry-farming Methods and Practices in Wheat Growing in the Columbia and Snake River Basins; Washington Agricultural Experiment Station Bulletin 192, A Review of the Agriculture of the Big Bend Country, and Popular Bulletin 135, Farming in the Big Bend Country.

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The precipitation in this area occurs during the fall, winter, and spring months, much of it in the form of snow. The months of June, July, August, and September usually are very dry. The dry-land wireworms have become adjusted to this condition so that they feed only during March, April, and May, or as long as the temperature remains relatively cool, and there is moisture in the surface soil. Wireworms of this species are fairly evenly distributed in the soil of the grainfields over all the area infested. To be sure, damage sometimes becomes more apparent in spots, but this is because conditions of soil temperature, moisture, or texture are generally more favorable in these places for the wireworm to work and kill the stand of grain.

EXTENT AND NATURE OF INJURY

The Great Basin wireworm does considerable damage every spring (1) to the winter wheat, especially to stands that have not survived the winter in a thrifty condition, and (2) to the spring wheat which is being seeded about the time the wireworms are becoming active in the soil.

They travel the path of least resistance in the soil, which is usually along the drill row, feeding on the kernels and plants. One wireworm can account for the death of several plants, and the average loss to the grain in districts infested with this wireworm is done by only one or two wireworms per square yard.

Injury by wireworms to winter wheat varies with the weather conditions during the winter and spring, the injury being more noticeable in years of severe winter killing. The wireworms will thin out the stand of grain in the spring, often necessitating the reseeding of winter-wheat fields to spring grain. This is especially true in seasons when the weather remains cool and wet for a considerable period. A warm spring that will allow the wheat to grow and stool out rapidly will largely offset any noticeable damage which may be done by wireworms, even though they may be feeding on the plants as usual.

In the spring-seeded grain the wireworms attack the kernels as soon as planted, in some cases actually preventing germination. They also attack the underground portions of the wheat plants after sprouting, killing out the stand in spots. After the plants begin to stool the damage done by wireworms becomes much less noticeable. On the advent of hot weather in May and June, when the soil dries out below the crowns of the plants, the wireworms descend deeper into the soil, and suspend feeding until the following spring.

The injury caused by wireworms is very distinctive. They burrow into the kernels of grain in the spring, leaving only the seed coat in the soil. They also attack the underground portions of both the winter and spring wheat plants, boring through the leaf sheaths and into the stems in such a manner as to cut off the growing point. The leaves and roots remain alive but in a dying condition for several days, the stems eaten by wireworms having a peculiar shredded appearance. After the plant has begun to tiller, any one of the growing points of the individual tillers may be cut off by wireworms, but without noticeable damaging effect, since the remaining growing points maintain development. This manner of attack dis-

tinguishes the damage done by the Great Basin wireworms from that caused by "false" wireworms,[3] as the latter wholly consume the grain and plants as they feed. False wireworms (fig. 2, *a*) are the young or larval stage of the large, black, so-called "stink" beetles to be found crawling around in the fields during the greater part of the growing season.

DESCRIPTION OF THE STAGES

EGG

The eggs are pearly white, nearly round, being only slightly longer than wide, and so tiny in size as to be almost invisible to the naked eye. They seem to bear a sticky substance that causes small particles of soil to adhere to them. The eggs are easily dried out and will not stand exposure to air conditions for more than a few minutes.

LARVA

The newly hatched young or larvae are pure white, with dark mandibles or jaws, and are barely one-sixteenth of an inch in length when emerging from the egg. After feeding and molting several times they become golden yellow in color, and they obtain a length of three-fourths of an inch when full grown. (Fig. 3, *b*, *c*, and *d*.)

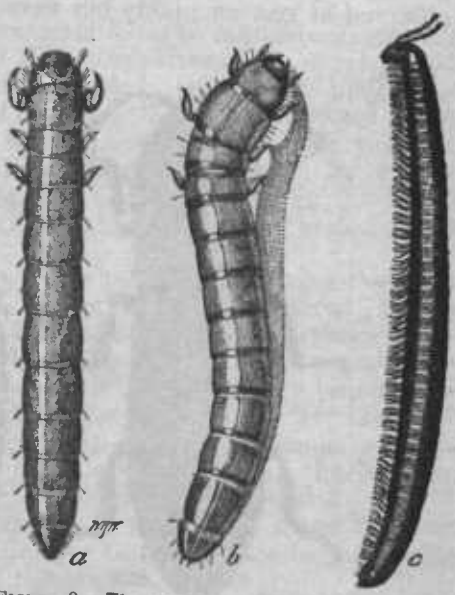

FIGURE 2.—These are likely to be mistaken for wireworms: *a*, False wireworm; *b*, mealworm; *c*, "thousand legger." About 2½ times natural size

PUPA

The pupa or transition stage is white, becoming dark yellow when the beetle is almost ready to emerge. The beetle is smoky white at first, but very soon becomes black.

ADULT

The adult beetles (fig. 3, *a*) of the Great Basin wireworm are jet black, slender, and measure about one-half inch in length. They are popularly known as "click beetles" or "snapping beetles," these names being derived from their habit of snapping the forepart of the body when placed on their backs or held between the fingers. Beetles from the southern portions of their range in Oregon and Idaho average slightly larger and more robust. The appearance

[3] Various species of the genus Eleodes. For further information concerning false wireworms, see the following publications: Journal of Agricultural Research, volume 22, pages 323–334, Biology of *Embaphion muricatum*; volume 26, pages 547–566, Biology of the False Wireworm *Eleodes suturalis* Say; and Idaho Agricultural Experiment Station Research Bulletin 6, False Wireworms Injurious to Dry-Farmed Wheat and a Method of Combating Them.

of the sexes is similar, but the female is slightly more robust than the male, having shorter antennae, and with segments not so much flattened as in the male.

LIFE HISTORY AND HABITS

The adult beetles (fig. 3, *a*) of the Great Basin wireworm normally emerge from the soil when the temperature at a depth of 8 inches reaches about 55° F. This condition generally follows a two or three day period of warm weather from May 1 to May 15, in the latitude of central Washington. Male adults fly freely on sunny days when temperatures are above 65° F., but their total period of life usually does not exceed three weeks. The males have been observed at rest on plants but never have been seen to feed during

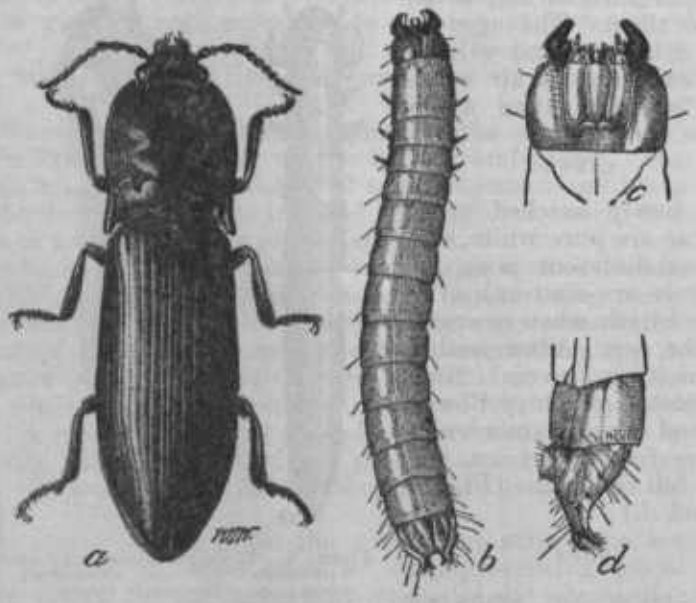

FIGURE 3.—The Great Basin wireworm: *a*, Adult; *b*, larva; *c*, under surface of head of larva; *d*, side of last segment of larva. *a*, *b*, About 5 times natural size; *c*, *d*, about 12 times natural size

their short period of existence. Observations during several seasons have never disclosed a female adult in flight and rarely has the female been found abroad in the fields. She apparently remains quietly under a clod, until found by the male, and probably migrates only short distances by crawling on the surface of the ground.

After mating the female burrows down to deposit her eggs in the cool, moist soil at a depth of several inches. All the evidence accumulated tends to show that the eggs are deposited in one place and within a relatively short period.

In experiments made in an underground laboratory the time passed before egg laying occurred was found to be about three weeks, and the egg stage lasted about four weeks. These periods varied with individual females. Most of the females laid about 350 eggs, but some of them laid over 500 eggs each.

The eggs of the Great Basin wireworm hatch during the latter part of June, and the young wireworms gain their first food from the living rootlets of grain and weeds. They increase in size very slowly, attaining a length of only about one-fourth of an inch the first year. Wireworms usually molt or cast their skins twice a year, though some individuals molt only once, while others go through as many as four or five molts in a season. Molting does not seem to take place during the active feeding season, the first molts occurring not earlier than June, others coming in August, and some as late as September. In the laboratory experiments half to full grown larvae that were not given any food throughout the season molted the same number of times as those fed regularly, and after several years without perceptible feeding some of these starved wireworms pupated and became adults.

The shortest time that this wireworm takes to complete its growth is not less than three years, and this is apparently the usual period for the greater number in each generation. However, under unfavorable conditions of food and soil these worms often do not transform to beetles the third year, but remain unchanged for years or until the conditions are suitable for pupation. Under laboratory conditions a few of these wireworms have remained in the larval state for 10 years and these individuals have molted at least once each year.

The wireworms usually change to the pupal stage during the third year of their life in late July and August, at a depth of about 7 inches in the hard, packed soil just below the plow line. The average depth of plowing in this region is 5 inches. The change to the pupal stage takes place in the soil in a vertical cell which is slightly larger than the pupa. The beetle emerges from the pupal skin after about 10 days but remains in the cell until the following spring, when it burrows out of the soil. The beetles are not hurt in the least by freezing temperatures during the winter. The 1, 2, and 3 year old larvae spend the winter deep enough in the soil to avoid freezing temperatures and then work their way to the surface in the spring as soon as the last frost is out of the ground.

Probably the minimum length of the life cycle of this wireworm, from the egg to the beetle ready to lay eggs, is four years.

NATURAL ENEMIES

The natural enemies of wireworms are comparatively few and can not be depended upon to control them. Great Basin wireworms are very rarely attacked by other insects, only a few insect enemies being known. Birds are fairly effective enemies of the beetles of this wireworm during its emergence period in the spring. Examination of the stomach contents of birds collected during the period of adult emergence has revealed remnants of great numbers of beetles. Any means of protecting and increasing the abundance of bird life in the dry-farming areas is to be highly commended, especially in the case of the Columbian horned lark (*Otocoris alpestris*), commonly called "wheat bird" or "dust bird." This native bird is found over nearly the same range as the Great Basin wireworm, and nearly all of the stomach contents of these birds

examined during the spring emergence of the wireworm adults showed that they contained remnants of from 1 to 30 of these beetles. The Bureau of Biological Survey reports that 40 species of birds are known to feed on species of the genus Ludius, to which the Great Basin wireworm belongs, and that in general birds prey freely upon wireworms and their parent click beetles.

CONTROL MEASURES

CLEAN SUMMER FALLOW

The critical period in the life of this wireworm is in the first year of its existence immediately after emergence from the egg. This occurs in the last part of June or early in July when the tiny young larva must have growing, succulent food in order to survive under the very dry conditions met with in its native home at this season. Usually, at this time of the year there are two different soil conditions to be found in the fields inhabited by wireworms.

(1) There is a very unfavorable condition where the current year's crop of wheat is approaching maturity for harvesting during July and early August. All available moisture in the soil at such a time has been taken up by the crop to a depth of several feet, leaving the ground hard, packed, and supporting hardly any succulent vegetation. Under these conditions the first-year wireworms have a very hard struggle and little chance of surviving their first season.

(2) There is a more favorable condition in such spring-plowed fields as are lying fallow for the next season's seeding. If the summer fallow is plowed early and properly there should be enough moisture under the surface mulch to permit the survival of a considerable number of first-year wireworms. However, the best farm practice under a summer-fallow system calls for frequent cultivation to keep down weed growth[4] (fig. 4) and thus prevent any loss of moisture or nitrates from this cause. Doing away with weeds also acts against the wireworms by destroying their only available food supply, thus preventing them from surviving the first season. If a summer fallow is allowed to become in any degree weedy (fig. 5) this will permit a considerable population of wireworms to live through the first summer and be ready to take advantage of the abundant food furnished by the wheat crop of the next spring. After they have entered their second year, it is relatively easy for the wireworms to adjust themselves to almost any unfavorable condition and still survive. A weedy summer fallow for only one season would mean several years of damage from wireworms, because of their long life and ability to survive after their first season. Hence the first and most important control recommendation against the dry-land wireworm is this: Always keep the summer fallow absolutely clean.

SPRING HARROWING NOT RECOMMENDED

It has been a common practice for many years to harrow the winter wheat in the spring as soon as frost is out of the ground. This is intended to break the hard surface crust and enable the

[4] The three most important weeds occurring on summer fallow in this dry-land region are Russian thistle (*Salsola pestifer* Nels.), tumbling mustard (*Sisymbrium altissimum* L.), and tumbleweed (*Amaranthus graecizans* L.).

FIGURE 4.—A clean summer fallow which starves out the newly hatched wireworms in their first season. The hills in the background are all farmed and the grain is harvested with combines

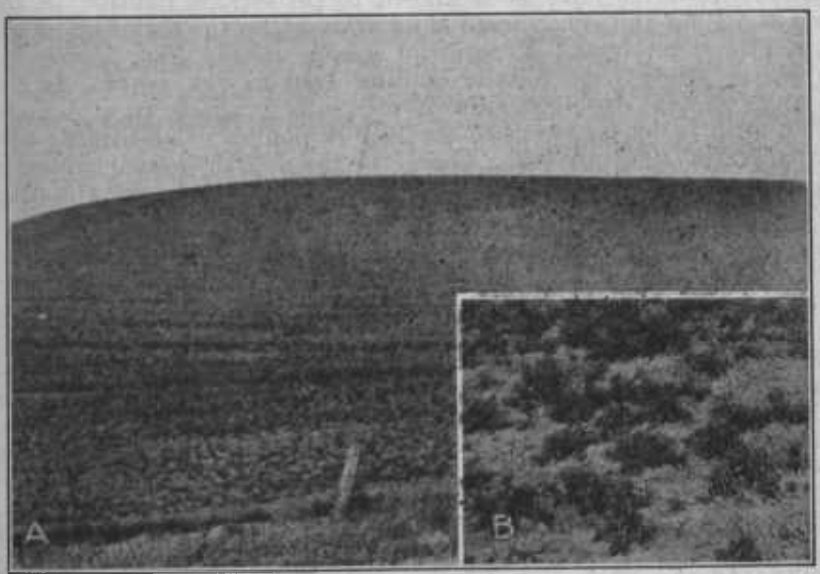

FIGURE 5.—A, A weedy summer fallow which allows the newly hatched wireworms to obtain food and survive their first season. The growth is mostly tumbleweed, with some Russian thistle. B, Close-up view of a weedy summer-fallow field. Enough newly hatched wireworms will survive their first season under these weeds to keep up a damaging population

plants to grow better. As a matter of fact, experiment-station investigations have shown that such harrowing is unnecessary and often is actually injurious to the young plants in the spring. This harrowing merely loosens up the soil and allows the wireworms more easy access to the plant stems. Therefore, the second general recommendation for control is: Do not harrow winter wheat in the spring.

EFFECT OF SEED DISINFECTION ON WIREWORMS

Copper carbonate dust for disinfecting grain for smut has come into use in recent years and where wireworms are present this treatment has several features to recommend it over the old, wet bluestone or formaldehyde dipping treatments. Treating seed wheat with dry copper carbonate seems to produce more vigorous and faster growing stands of wheat with less injury to the seed. The better and quicker germination shortens the time before tillering when the wireworms can cause serious damage to the slender stems, and the thicker, more thrifty stands of spring wheat obtained from dry-treated seed are less hurt by the thinning caused by the wireworms. Hence the third recommendation is apparent: Treat seed with dry copper carbonate to prevent smut.

PLANT SEED MORE THICKLY IN WIREWORM-INFESTED LAND

The recommendation of planting more seed to offset damage by pests is very applicable in the seeding of spring wheat where the wireworms are abundant. The use of slightly more seed in areas where wireworms have been known to do serious damage in the past is a good and cheap method of overcoming the thinning of the stand by wireworms. Experiment-station results have shown no injurious effects from heavier seeding even in dry years. As the average damage from wireworms to spring grain is from 5 to 10 per cent, it is not necessary to use over 10 pounds of additional seed per acre for this purpose. Therefore the fourth recommendation should be: Use seed enough in the spring to allow for some thinning by wireworms.

CHEMICALS OF NO AVAIL AGAINST WIREWORMS

Chemicals of various sorts have been tried out against wireworms on these vast dry-farming areas, both in connection with seed treatment for smut control and as poisons or repellents to the wireworms themselves. No treatment of this sort would be effective in the fall-sown winter wheat, as the damage is done to the plants in the following spring. In the case of spring wheat no chemical has yet been found that is effective enough as a poison or repellent to be of practical use. Some chemicals retard the germination of grain, and some act merely as repellents while on the grain itself; but all are ineffective to prevent damage by the wireworms to the resulting plants. In the final analysis, any such chemical is too expensive to use over the vast areas involved in damage caused by Great Basin wireworms.

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